already known, with some additional facts obtained by the observation of himself and his brother missionaries. There is a map and a few good illustrations.

Three Months in the Soudan. By Ernestine Sartorius. (London: Kegan Paul and Co., 1885.)

MRS. SARTORIUS spent most of her three months in 1883-84 at Suakim, of which her husband, Gen. Sartorius, was Commandant. Her book deals chiefly with the events which culminated in the disaster of El-Teb. It is mostly a pleasant, gossipy record of the daily life of the town, and of the alarms created by the attempted raids of the rebellious natives in the district around. It affords a good idea of the character of the town and its immediate surroundings.

Lectures on Agricultural Science and other Proceedings of the Institute of Agriculture, South Kensington, London, 1883-84. (London: Chapman and Hall.)

THIS volume contains abstracts of lectures delivered by a considerable number of well-known authorities upon agricultural matters. Mr. Carruthers and the late Prof. Buckman give their experiences upon grasses and farm seeds; Prof. Wrightson has a paper upon land drainings; dairy management and farm crops are treated of by Professors Huldon and Fream and Mr. Bernard Dyer; Mr. Henry Woods contributes lectures upon Southdown sheep and ensilage; while Mr. Warrington has a contribution upon the nitrogenous matter in soils; and Mr. Worthington Smith gives some good observations upon corn mildews. The names of the authors of the various lectures are a sufficient guarantee of their soundness and worth.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Sir William Thomson's Baltimore Lectures

As it is possible that some of your readers may have obtained copies of the Papyrograph Report of my Lectures on "Molecular Dynamics," delivered at Baltimore during October 1884, I should be obliged by your giving publicity to the following corrections:—

Page 34, lines 18 and 19.—Delete "we may call it a dynamox but not a paradox." I have no recollection nor can I imagine what the word was that I suggested as more logical than "paradox"!

Page 59, line 14.—For "Distortional" substitute "Condensational."

Page 296.—In the two expressions for ψ, given in equation (17), insert "tan i" before "$\frac{(\mu^2-1)^2}{\mu^2+1}$"; also, in the expressions for "tan e" and "tan e_1" of equation (20) insert "tan i" before "$\frac{(\mu^2-1)^2}{\mu^2+1}$".

The formula from which these expressions are deduced is correctly given at the foot of page 295.

Page 296.—In line 13 from the top of the page, and in the left hand members of equations (19) and (21), for "ω" and "ω_1" read "$\bar{\omega}$" and "$\bar{\omega}_1$" respectively.

WILLIAM THOMSON

The University, Glasgow, February 27

Civilisation and Eyesight

IT would take too much of your space to discuss at length the theoretical limit of resolving-power as depending upon aperture. The reader may be referred to some papers in the *Philosophical Magazine* for 1879 and 1880, where he will also find references to the work of other investigators. I will only say that (as indicated by the word *fairly* in my statement) resolution admits of various degrees. Doubtless a practised observer would judge a star to be double whose components subtend a decidedly smaller angle than two minutes, but he would not see them separated. I purposely rather understated the case. The higher the visual power of civilised men, the less room is there for savages with eyes of equal aperture to surpass them.

With respect to my short-sightedness in a bad light, I shall be glad if you will publish the accompanying two short papers from the *Cambridge Philosophical Proceedings*. They will show how I was led to make the discovery. RAYLEIGH

"The Use of Telescopes on Dark Nights." By Lord Rayleigh. (From the *Camb. Phil. Proc.*, March, 1882.)

In *Silliman's Journal* for 1881 Mr. E. S. Holden, after quoting observations to a like effect by Sir W. Herschel, gives details of some observations recently made with a large telescope at the Washburn Observatory, from which it appears that distant objects on a dark but clear night can be seen with the telescope long after they have ceased to be visible with the naked eye. He concludes, "it appears to me that this confirmation of Herschel's experiments is important, and worth the attention of physicists. So far as I know there is no satisfactory explanation of the action of the ordinary night-glass, nor of the similar effect when large apertures are used."

It is a well-known principle that no optical combination can increase what is called the "apparent brightness" of a distant object, and indeed that in consequence of the inevitable loss of light by absorption and reflection the "apparent brightness" is necessarily *diminished* by every form of telescope. Having full confidence in this principle, I was precluded from seeking the explanation of the advantage in any peculiar action of the telescope, but was driven to the conclusion that the question was one of apparent magnitude only,—that a large area of given small "apparent brightness" must be visible against a dark ground when a small area would not be visible. The experiment was tried in the simplest possible manner by cutting crosses of various sizes out of a piece of white paper and arranging them in a dark room against a black background. A feeble light proceeded from a nearly turned-out gas-flame. The result proved that the visibility was a question of apparent magnitude to a greater extent than I had believed possible. A distance was readily found at which the larger crosses were plainly visible, while the smaller were quite indistinguishable. To bring the latter into view it was necessary either to increase the light considerably, to approach nearer, or lastly to use a telescope. With sufficient illumination the smallest crosses used were seen perfectly defined at the full distance.

There seems to be no doubt that the explanation is to be sought within the domain of physiological optics. It has occurred to me as possible that with the large aperture of the pupil called into play in a dark place, the focussing may be very defective on account of aberration. The illumination on the retina might then be really less in the image of a small than in the image of a large object of equal "apparent brightness."

"On the Invisibility of Small Objects in a Bad Light." By Lord Rayleigh. (From the *Cambridge Phil. Proc.*, Feb., 1883.)

In a former communication to the Society (March 6, 1882) I made some remarks upon the extraordinary influence of apparent magnitude upon the visibility of objects whose "apparent brightness" was given, and I hazarded the suggestion that in consequence of aberration (attending the large aperture of the pupil called into operation in a bad light) the focussing might be defective. Further experiment has proved that in my own case at any rate much of the effect is attributable to an even simpler cause. I have found that in a nearly dark room I am distinctly short-sighted. With concave spectacles of 36″ negative focus my vision is rendered much sharper, and is attended with increased binocular effect. On a dark night small stars are much more evident with the aid of the spectacles than without them.

In a moderately good light I can detect no signs of short-sightedness. In trying to read large print at a distance I succeeded rather better without the glasses than with them. It seems therefore that the effect is not to be regarded as merely an aggravation of permanent short-sightedness by increase of aperture.

The use of spectacles does not however put the small and the large objects on a level of brightness when seen in a bad light, and the outstanding difference may still be plausibly attributed to aberration.

MR. CARTER'S recent paper on "Civilisation and Eyesight" has called up interesting remarks from Lord Rayleigh and Mr

J. R. Capron, but there seems to be a factor yet unconsidered connected with sharpness of eyesight which is not dependent on the varying aperture of the pupil of the eye. The same amount of light exerts different degrees of stimulus on different individuals, and even in the same person the optic nerves are differently affected, according to his health or age. The pathologist is familiar with the exalted irritability induced by inflammation.

The observer of close double stars becomes in time painfully aware that through age his power of appreciating minute points of light is blunted, although his eye may be in a healthy condition, and quite equal to microscopic work under suitable illumination.

The flattening of the cornea, together with the slow reduction of the curves of the crystalline lens, is a common occurrence, and this change is said to commence at the age of forty-five.

Modification of form and the inability to vary the distance between the lens and the retina, due to defective power in the muscles of the iris, are the chief causes of short sight. On the other hand, the eye appears to have great capabilities of modifying itself to circumstances. It may degenerate by disuse, and even become obliterated, as may be seen in the blind aquatic beetles of dark caverns, the flea of the bat, and in many species of underground Aphides. Similarly it would seem that the eyes of the student who habitually pores over half-legible German or other type, or the eyes of the watchmaker or the engraver, who use lenses, will permanently accommodate themselves to the short foci required to view objects at short distances, and such modifications may be conceived to become hereditary.

The pupil of the eye perhaps has an aperture wide enough to admit the pencil of light from any telescope; yet it may be worth some consideration whether the sensitiveness of the eye may not for certain purposes be increased, under due precautions, by the use of some such drug as atropa belladonna. The iris thus might be made less contractile under the overpowering light of a planet, and perhaps allow a better observation of a minute satellite revolving close to its primary. It is a well-recognised fact that a faint star once seen may often afterwards be detected with comparative ease by other persons, if its position be truly shown.

Venus may be often seen in broad daylight, if the planet be pointed to by suitable marks.

Care of course would be taken that the use of belladonna shall not cause the observer to see too much. G. B. BUCKTON

THE controversy in NATURE on this subject has brought back to my thoughts a singular illustration of the power of trained eyesight which seems worth noting, though it does not touch the exact comparison between savage and civilised eyes which is the immediate subject of the letters which have appeared in your columns. I refer to the vastly greater capacity for determining visual direction supplied by the sense of symmetry than by actual discrimination between two slightly distant visible points. If you look at a circle, you can aim at its centre with far greater exactitude than you could aim at a point in the true centre of the figure. Every rifleman and every billiard-player exemplifies this. Suppose a billiard-ball placed a little less than five feet from a pocket, and played at as a half-ball stroke from an equal distance for a winning hazard. This is something like what has to be done from baulk in making a pair-of-breeches stroke into the corner pocket. A fair amateur will pot his ball pretty often; a first-rate professional will do it very often. No one, perhaps, can make it a really safe stroke. But observe the accuracy required. The margin of error allowed on each side of the perfect stroke is, on a severe table, not more than an inch at the pocket. This allows an error on each side of about one degree in the point of impact with a radius of one inch (the ball being two inches in diameter). This one inch subtends at the distance from which the stroke is played (nearly 5 feet), an angle of $1^\circ \times \sin 60^\circ$, $\frac{1}{60}$ = about '8'. To make the stroke you must first, by eye, place your striking-ball right, then you must, by eye, aim the stroke right, and finally you must make the muscles follow the eye rightly. These three elements of error combined must leave a resultant error of not more than four-fifths of a minute; that is to say, a successful stroke must have a total angular error very considerably less than the smallest angular distance which the eye can appreciate between two visible points. This, of course, explains also the superiority of a rifle foresight, which surrounds the object by a symmetrical figure over one which depends on making one point visibly cover another. G. W. H.

Human Hibernation

As it is obvious that Mr. A. H. Hulk is unacquainted with the facts of what he designates a "well-known Indian trick," and as the matter is one of considerable physiological interest, I think it well to place before your readers the nature of the evidence which satisfied me of the genuineness of this condition, when I referred to it in the fourth edition of my "Human Physiology," published thirty-two years ago—a reference retained by the present editor of that treatise. This evidence had been obtained by Mr. Braid from Indian sources, and published by him in a collected form in 1850, the greater part of it having previously appeared in the pages of the *Lancet*. The most important feature of it was the testimony of British medical officers who witnessed the exhumation—most explicitly given in at least three distinct cases—*to the corpse-like condition of the buried man*, a condition which could not be simulated.

I have since learned from a variety of trustworthy sources, that similar testimony has been over and over again given in India by competent witnesses. Moreover, in one of the cases adduced by Mr. Braid, on information supplied to him direct by the British resident in the summer-house of whose garden the man was buried, the circumstances of the inhumation and of the exhumation were such as absolutely to exclude the "tunnel" hypothesis; while in the case narrated by Lieut. A. Boileau in his "Narrative of a Journey in Rajwarra," 1835, the man was buried in a grave lined with masonry and covered with large slabs of stone.

It is further worthy of mention that this performance is not carried on for the sake of gain, but as a religious observance. Many years ago Prof. Max Müller, finding that I was interested in the matter, kindly placed in my hands a pamphlet printed in India, containing a summary of what is termed the Yoga or Yogi philosophy. The devotees of this system have from time immemorial been in the habit of artificially inducing states of more or less complete abstraction, corresponding closely with those of Braidism; and the condition of apparent death, in which the soul is supposed to leave the body for a time, for communion with the higher world, is the culmination of these conditions, only to be reached by the few; to whom, in consequence, a character for the highest sanctity attaches itself.

With the well-authenticated fact of Col. Townsend's self-induction of a state of apparent death, and of his spontaneous recovery from it, as a "leading case," I cannot regard it as incredible that such a condition of "dormant vitality" might be prolonged for days, weeks, or even months, *in a warm atmosphere*. The suspension of the heat-producing power would of course leave the body susceptible of a fatal reduction of temperature, if its warmth were abstracted by a surrounding medium much cooler than itself WILLIAM B. CARPENTER

Athenæum Club, February 20

Methods of Determining the Density of the Earth

I HAVE just seen in the report of the proceedings of the Physical Society (NATURE, January 15. p. 260) the account of the ingenious and very important experiments proposed by Drs. König and Richarz to determine the density of the earth. I would suggest that mercury be substituted for lead as the attracting masses. The homogeneity of density, the precision with which its density and temperature can be determined and the ease with which transport from one side of the balance to the other can be effected will commend the use of mercury. The mode of experimenting suggested is the plan of Cornu—used in his determination of the density of the earth by the (Cavendish) Michell experiment—adapted to the same determination by means of the balance.

Let A, B, C be the balance, D E the attracted balls, and F G, H I, the attracting masses of mercury contained in iron spheres of the same capacity, size, and weight. A large mass of mercury is contained in the vessel M, so placed that it has no effect on the balance or on D or E. The balance being in equilibrium with the mass D and E, mercury is allowed to fill F and I, and the effect noted in oscillations after F and I are filled. Then the mercury is drawn from F into H, and G is filled from the reservoir M, and I is emptied, and the second observation obtained. Then D and E are interchanged, and a third observation obtained. Then the mercury in G is run into I, F is filled, and H emptied, and the third observation made, the combination of these four observations making one determination. Electrical effects of